REMARKS

The Office Action of May 6, 2010 has been received and carefully considered. However, Applicant respectfully disagreed with the obviousness rejection under 35 U.S.C. 103. All claims are now present for examination and favorable reconsideration is respectfully requested in view of the previous amendments and the following comments.

REJECTIONS UNDER 35 U.S.C. §103:

Claims 1 and 4 – 17 have been rejected under 35 U.S.C. §103 as allegedly being unpatentable over Tubel (US Pat. Appl. Pub. No. 2003/0094281 A1) in view of Varasi (US 5,493,390).

Applicant traverses the rejection and respectfully submits that the embodiments of present-claimed invention are not obvious over the cited prior art references. Regarding Claims 1 and 16, Varasi discloses the use of fibre Bragg Grating to measure the stress and strain, whereas Tubel discloses fibre Bragg grating and other optical sensors for railway applications. However, it should be noted that the device disclosed in Tubel has inherent limitations that make it impossible to be applicable in a railway monitoring system. Specifically, Tubel at paragraphs [0099] and [0114] to [0116] states that:

> "[0099] In a preferred embodiment, fiber optics cables 20, 22 have no associated discrete sensors 32. Instead, the fiber optics cable itself is used to acquire the necessary information using Raman and/or Rayleigh and/or Brillouin techniques wherein reflected photons are monitored from the surface and utilized. The advantage of this latter embodiment over the use of single point or distributed downhole sensors 32 (such as the Bragg grating sensors 32 described in the aforementioned patents) is improved reliability, lower cost as well as more precise measurements.
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> ...
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> [0114] Referring now to Fig. 5, the transportation industry also has requirements for intelligent structure. By way of example and not limitation, the present invention may be used for monitoring of the process of construction of a highway or rail system (shown in the figure as rail system 300). The present invention may be used to determine stress, strain,

pressure, temperature, vibration and other parameters that arc exerted on the structure during the construction of the structure, e.g. the road bed or rail bed 302. Distributed fiber sensing device 30 may be embedded in the structure or placed on the outside of the structure, i.e. rail 304, to monitor the structure and help assure compliance with manufacturing requirements. By way of example and not limitation, distributed fiber sensing device 30 can determine if there is a problem with the rail system that could cause the train to derail. The ability to monitor strain along the axis of a fiber optic cable 20 associated with distributed fiber sensing device 30 provides this unique capability. Further, the ability of Brillouin technology to monitor events occurring along distributed fiber sensing device 30 may provide a resolution of ten centimeters or better, thus allowing for accurate measurement of the entire length of fiber Optic cable 20 instead of discrete points in fiber optic cable 20.

[0115] Using rail system 302 as an example, the present invention may be used to determine a train's location in the system monitored by distributed fiber sensing device 30 because the train will cause a strain in rails 304 as well as vibration that can be detected by distributed fiber sensing device 30. Further, the present invention may be used to monitor wear of rail system 302 (or bridge or road) due to the traffic on the structure. By way of example and not limitation, the present invention can detect the stress and strain on rails 304 using distributed Rayleigh, Brillouin, or Raman scattering techniques or other techniques used to obtain information as the light reflects as it travels in and out of fiber optic cable 20. In this manner, <u>distributed fiber sensing device 30 and discrete sensors 32 located throughout rail system 302 or road system may also be used to monitor other adverse conditions such as subsidence of the ground that can damage the structure</u>. The use of distributed fiber sensing device 30 to detect and measure physical parameters such as pressure, temperature, strain, and acoustics can assure that the structure is being monitored properly.

[0116] The use of distributed temperature and strain techniques related to Rayleigh, Brillouin, and Raman and other reflection and photon or phonon scattering techniques can provide a significant advantage over electric and mechanical sensors 32. By way of example and not limitation, the entire structure 302 cm be monitored using a single fiber optic cable 20 instead of deploying multiple sensors. <u>Reliability can be improved if no sensors 32 are deployed in rail 302, using reflected photons from the light travelling into fiber optic cable 20 instead.</u>" (emphasised added)

Based upon the above reference, it would be apparent to those skilled in the art that Tubel has categorized fibre Bragg grating as a discrete sensor or at best as a semi-distributed

sensor. However, the main focus of the Tubel invention is to use distributed sensors based on "Rayleigh, Brillouin, and Raman and other reflection and photon or phonon scattering techniques" to measure the railroad conditions to address the inadequacy of discrete sensors, including fibre Bragg gratings, for railroad condition measurements.

It is respectfully submitted that the proposed technique in Tubel is not applicable to the monitoring/measurement of operation conditions of the railway industry since the typical measurement/response time using the techniques mentioned by Tubel would take more than a minute to arrive at train location resolutions of tens of centimeter. Although shorter measurement time is possible, it may be necessary to shorten the measurement distance and reduce sensitivity. For example, the same machine takes 4 minutes to measure strain with sensitivity of 5με over a range of up to 5 km with 1-m resolution, and takes 10 seconds to measure strain with sensitivity of 5 με over a range of up to 1 km. Based on the experience of the inventors in the field of railway monitoring over the years, a practical system needs to deal with distances of longer than 1-km and sensitivity better than 5 με. Typical induced strain due to a passing train on a rail track is about 120 με (as in the KCRC trains in Hong Kong). Typically, it is required to have resolutions of 5 με in order to differentiate the different conditions such as trains stopping in the vicinity of the optical detectors and so on. As such, to achieve sufficient resolution, the invention of Tubel would typically take a minute to measure strain, by which time the train has long passed the location at which the strain or stress is measured, and therefore the system of Tubel would be unable to monitor a running railway network.

Tubel states that "[r]eliability can be improved if no sensors 32 are deployed in rail 302, using reflected photons from the light travelling into fiber optic cable 20 instead." Tubel also states that "[t]he advantage of this latter embodiment over the use of single point or distributed downhole sensors 32 (such as the Bragg grating sensors 32 described in the aforementioned patents) is improved reliability, lower cost as well as more precise measurements." Based upon these references, it would be apparent that those skilled in the art would be <u>taught away from</u> using fibre Bragg grating for

monitoring conditions of the railway. That is, although fibre Bragg grating is being mentioned, Tubel has in fact positively discouraged the use of fibre Bragg grating for monitoring the conditions of railway infrastructure. Furthermore, it is difficult to ascertain whether the Bragg gratings have been dislocated unless the pre-strain technique proposed in the present invention is used.

More importantly, Tubel discloses distributed fiber sensing device 30 and discrete sensors 32 located throughout rail system 302 for measuring parameters (see paragraph [0115]), and teaches further that the entire rail 302 can be monitored using a single fiber optical cable 20 instead of deploying multiple sensors 32 in rail 302 (see paragraph [0116]), Applicant respectfully submits that these references suggest that discrete sensors such as fibre Bragg grating sensors are not recommended by Tubel.

In view of the above, Applicant respectfully requests that the rejection against Claims 1 and 16 be withdrawn on the basis that Tubel discloses that the fiber sensor can be a Bragg grating (paragraph 0077). Again, Applicant submits that Tubel has categorically mentioned that fibre Bragg grating is not encouraged to be used, on the basis that Tubel states that "[t]he advantage of this latter embodiment (i.e. sensors using Rayleigh, Brillouin, and Raman and other reflection and photon or phonon scattering techniques) over the use of single point or distributed downhole sensors 32 (such as the Bragg grating sensors 32 described in the aforementioned patents) is improved reliability, lower cost as well as more precise measurements." In other words, fibre Bragg grating sensors are considered to be inferior and are not recommended by Tubel for railway monitoring. As such, Applicant submits that the present invention would not have been obvious over Tubel, even it is considered alone or in combination with Varasi.

Regarding Claim 4, Applicant respectfully disagrees with the Examiner's assertion that those skilled in the art would be motivated to pre-strain the Bragg grating in order to increase the detection sensitivity. By contrast, Applicant submits that the reasons

for pre-straining the sensor is not to increase the detection sensitivity of the fibre Bragg grating sensors, but rather to inform the interrogating system whether the fibre Bragg grating sensors are firmly attached to the location at which the fibre Bragg gratings are supposed to attach. This feature is particularly critical to railway for safety purposes as it could be used to inform the system if the sensor's information is truly reflecting the situation of the track condition. As such, without clear teaching from prior art, it would not have been obvious to those skilled in the art to pre-strain the Bragg grating in the system of Tubel or Varasi so as to arrive at the invention of Claim 4.

Regarding Claims 5 – 17, Applicant respectfully disagrees with the Examiner's assertion that those skilled in the art would have combined Tubel and Varasi. More specifically, as discussed above, Tubel has positively taught the user to use sensors using Rayleigh, Brillouin, and Raman and other reflection and photon or phonon scattering techniques to measure parameters in a railway network. These distributed optical fibre sensor systems are perfect for measurement of slower events over long distances. Their performances are reduced significantly for measurements that require fast measurement time and high sensitivity. Tubel would not work as a railway monitoring system according to the present invention as the response time of the distributed sensors by Tubel is far too slow to be of any use in a running railway network. By the time the system can identify the location of two trains using the techniques proposed by Tubel, the trains would have moved miles of distance and they might even have already collided. As such, these systems would not be applicable to monitoring of a running railway network according to the present invention. In view of the above, Applicant submits that Claims 5-17 would not have been obvious to those skilled in the art.

Therefore, the rejection under 35 U.S.C. §103 has been overcome. Accordingly, withdrawal of the rejections under 35 U.S.C. §103 is respectfully requested.

Having overcome all outstanding grounds of rejection, the application is now in condition for allowance, and prompt action toward that end is respectfully solicited.

Respectfully submitted,

JACOBSON HOLMAN PLLC

By ______________
John C. Holman
Registration No. 22,769

Date: November 4, 2010
(202) 638-6666
400 Seventh Street, N.W.
Washington, D.C. 20004
Atty. Dkt. No.: P71474US0